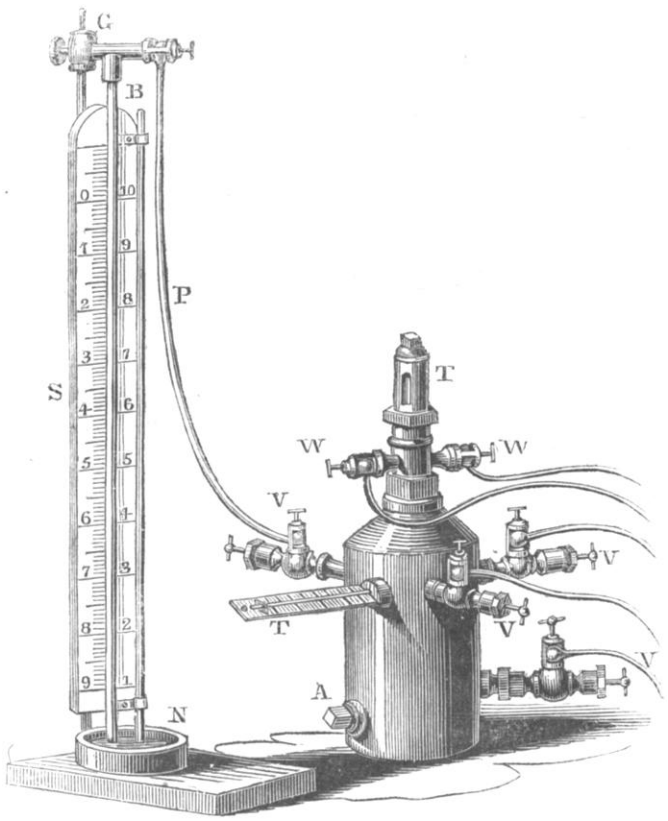
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ARTICLE XXIII.

Of an Improved Barometer Gage Eudiometer. By R. Hare, M. D., &c., &c., &c.

About eight years ago I published an account of a hydro-oxygen eudiometer, in which the measurement of the gases was effected by means of a barometer gage. In the apparatus then employed, the receiver was of glass, and was, of course, fragile. Subsequently I employed a stout iron bottle in lieu of the glass.

The essential constituents of this apparatus are an air tight vessel, sufficiently strong, and having screw apertures for the insertion of valve cocks, V V V, a thermometer T, and a galvano ignition apparatus* W W; also a barometer gage G, communicating by a leaden tube with the vessel through one of the valve cocks.

An air pump, pneumatic cistern or trough, and reservoirs for gas, are necessary auxiliaries.

It is an important characteristic of the barometer gage eudiometer, that it is applicable on a much larger scale than any other. It is only necessary to make the requisite apertures, and tap them for appropriate screws, in order to transfer the valve cocks, thermometer and ignition apparatus, with all the essential means of operating, to any air tight cylinder of any size; to a large cannon for instance, the mouth

* This is the name by which I have designated it in my text book.

being closed. The sources of inaccuracy, if any exist, must lessen in proportion to the result, as the quantity acted upon is augmented. It would, of course, be safer to extend the cylinder in length than in diameter.

Description of the Gage.

It is well known, that if a vertical glass tube communicate, through its upper orifice, with a receiver, while its lower orifice is situated beneath the surface of an adequate quantity of mercury, in any convenient receptacle; on exhausting the receiver, the metal will rise in the bore of the tube in proportion to the quantity of air removed. Hence, if zero of the ascending column of degrees, counting upwards from one to ten, be placed on a level with the surface of the mercury in the receptacle at the foot of the gage tube G, the quantity of gas condensed or withdrawn will be as the number of degrees opposite the surface of the column of the mercury in the gage tube.

Again, supposing it were possible to exhaust the vessel perfectly, the column of mercury in the gage, would attain the height of a well filled Torricellian tube. By having such a tube by the side of the gage tube, as represented at B in the figure, its orifice communicating with the mercury of the same receptacle, and placing zero of the descending column of graduations on a level with the surface of the mercury in the Torricellian tube, the quantity of air in the receiver will always be as the number of degrees, between the surface of the mercury in the gage and the surface of the same metal in the Torricellian tube.

The scale comprises ten divisions, each containing ten subdivisions. The whole scale may therefore be estimated to divide the capacity of a receiver into ten volumes, or into one hundred, whenever the zeros of the right and left hand columns of degrees coincide simultaneously, the one with the surface of the mercury in the receptacle, and the other with that of the Torricellian column. But on this it were vain to rely, since the altitude of the Torricellian column is liable to vary while the scale remains unchanged. This difficulty is, however, easily surmounted by restricting the length of the graduated part of the scale to the minimum height of the mercurial column, or twenty-seven

inches; and employing an excess of hydrogen when the quantity of oxygen is to be ascertained, and an excess of oxygen when the quantity of hydrogen, or hydrogen and carbon, are in question; the excess in either case, being made equal to the difference between twenty-seven inches, and the height of the Torricellian column. With this precaution, the quantities introduced or withdrawn, will always be to each other as the changes which they produce in the column of mercury in the gage tube. The rise of the mercury in the tube, will cause the surface of it in the receptacle D to be lower; but the breadth of this vessel is so great, and the descent of the mercurial surface in it is so inconsiderable, that no error worthy of attention is thus created.

I ought to mention, that the cavity of the gage tube ought to be so small in proportion to that of the receiver, as to create no error worthy of attention.

Description of the Galvano Ignition Apparatus.

An iron cylinder, of about an inch in bore, includes another concentric cylinder, or tube of glass. A platina wire, which, by being made the subject of a galvanic discharge, is employed to ignite the gaseous mixture, occupies the cavity of the glass. Opposite to it, two openings are made in the iron, which serve for windows, enabling the operator to see the progress of the ignition, and, consequently, to know when to break the galvanic circuit, in order to avoid fusing the wire.

Method of Operating.

In the engraving, a leaden tube is represented as making a communication between the gage tube and the cavity of the iron bottle, through one of the valve cocks. Let it be supposed that, by means of other valve cocks and tubes, like communications with an air pump, and one or more reservoirs of gas, are under the control of the operator.

In order to analyze the atmosphere, he should have at his command a communication with a bell glass containing, over water, a mixture

of five parts of air and three of hydrogen; also with a reservoir of hydrogen.*

These arrangements being made, exhaust the bottles; and admitting two or three volumes of hydrogen, exhaust again. By repeating this part of the process, nothing but hydrogen will remain in the vessel. Let the zero of the descending scale be situated on a level with the surface of the mercury in the gage tube, and then admit eight volumes of the mixture, which will be known to have entered when the surface of the mercurial column has fallen to eight on that scale. All the cocks being closed, ignite the platina wire. The explosion will be known to take place, both by the flash and sharp noise which it produces. As soon as these indications are perceived, the cock communicating with the gage may be re-opened. Nearly three volumes of the mixture will be found to have disappeared, and by the time that the thermometer indicates the temperature to be in statu quo, it will be found that the deficit arising from the combustion will a little exceed that quantity.

In analysing gaseous compounds of carbon with hydrogen, this apparatus may be advantageously employed; due proportions of the carburet and of oxygen gas being previously mingled in an appropriate vessel over water. Suppose, for instance, olefiant gas were in question; one volume of it being mixed with four of oxygen: after the explosion, two volumes will be found wanting; because, in one volume of the carburet, there are two of hydrogen and two of carbon vapour. Each volume of the latter, will unite with one of oxygen, without altering its volume. The two volumes of hydrogen will take one of oxygen, and be condensed with it into water. Of course, in lieu of the five volumes introduced, two volumes of carbonic acid, and one residual volume of oxygen will remain.

By means of the forcing air pump, described in the preceding pages, the gas may be transferred to a receiver, and washed with ammonia, or milk of lime, and then allowed again to enter the iron bottle.

* The necessary mixtures are effected either by means of the volumeters or the sliding rod gas measure, of which I published engravings and descriptions in Silliman's American Journal of Science, vol. 12, page 36, 1827; and in the London Philosophical Magazine for 1828, vol. 32, page 126.

Meanwhile, by due attention to the gage, the quantity which has been absorbed may be ascertained; and consequently, the proportion of carbonic acid resulting from the oxidizement of all the carbon in the gas subjected to analysis.

Instead of employing the forcing air pump, by substituting a large valve cock for the screw by means of which an aperture in the bottle at A is closed, mercury may be introduced through a funnel, and, by its pressure, the residual gas may be easily conveyed, by a flexible leaden tube, to a receiver over the mercurial reservoir, and analyzed in the usual way. For this purpose it is necessary that the valve cocks with which the mercury comes into contact, should be of iron or steel; and, accordingly, I employ such where mercury is to be used.

The gases may be supplied, without previous measurement and admixture, by receiving them into the bottle from their respective reservoirs, and measuring them as they enter, by means of the gage.*

* I subjoin engravings of the self-regulating reservoirs which I employ in such eudiometrical experiments as are described in the preceding article; also of the calorimotor, by means

Fig. 1.

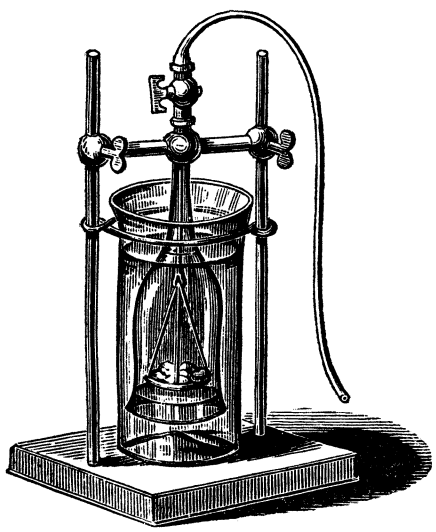
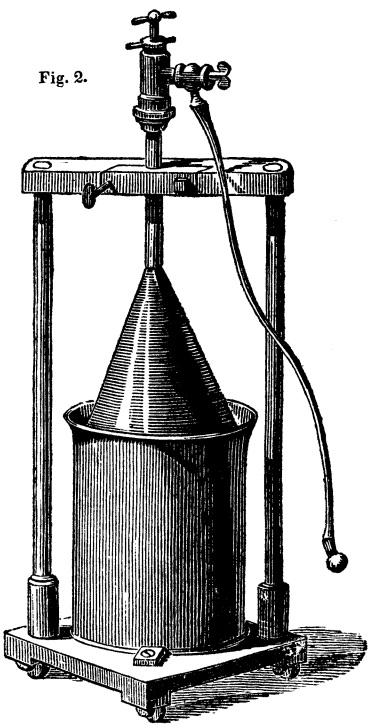


Fig. 2.



When hydrogen is employed to analyze the air, it should be the last admitted; since otherwise it is liable, from its lightness, to pre-occupy the cavity in which the platina wire is situated; so that some time would be required for its sufficient admixture with atmospheric oxygen to constitute a combustible mixture.

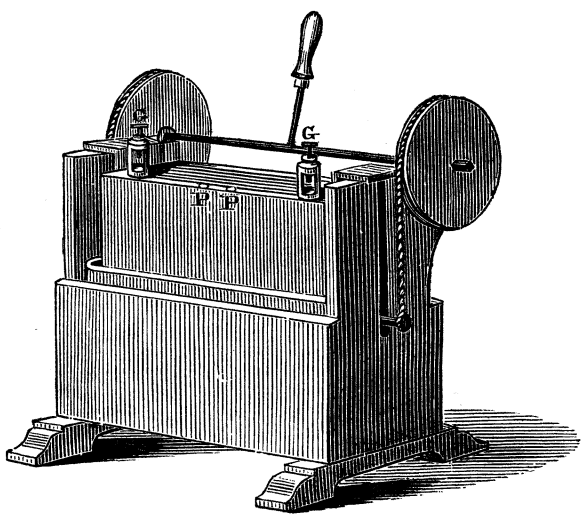
In this mode of operating, when the apparatus is once well arranged, the analysis of the air may be repeated as often as desired, and after any interval of time.

of which the ignition of the platina wire, and consequent inflammation of the gaseous mixtures are accomplished. There are two reservoirs, one of glass, fig. 1, the other of lead, fig. 2; the latter being about fifty times as large as the other.

As there is a perfect identity in principle of the construction in these reservoirs, an explanation of one will answer for both.

Suppose the glass jar to contain diluted sulphuric acid; the inverted bell, within the jar, to contain some zinc, supported on a tray of copper, suspended by wires, of the same metal, from the neck of the bell. The cock being open when the bell is lowered into the position in which it is represented, the atmospheric air will escape, and the acid, entering the cavity of the bell, will, by its reaction with the zinc, cause hydrogen gas to be copiously evolved. As soon as the cock is closed, the hydrogen expels the acid from the cavity of the bell; and, consequently, its reaction with the zinc is prevented, until another portion of the gas be withdrawn. As soon as this is done, the acid re-enters the cavity of the the bell, and the evolution of hydrogen is renewed and continued until again arrested, as in the first instance, by preventing the escape of the gas, and, consequently, causing it to displace the acid from the interior of the bell, within which the zinc is suspended.

This engraving will convey an idea of the calorimotor suitable to effect the ignition of the platina wire in the galvano ignition apparatus above described. It should contain two galvanic pairs, each consisting of two plates of zinc, 10 × 12, alternating with three of copper. The copper plates of one pair, and the zinc of the other being soldered to a common metallic strip, the other plates of zinc being soldered to one strip, the copper to another, each of the last mentioned strips is furnished with a gallows screw G G. Between these screws and those at W W, (see figure in the text) a communication is made by leaden or copper rods.



To complete the circuit, it is only necessary, to depress the handle attached to the pulleys, in order to raise the reservoir of diluted sulphuric acid, and thus to cause it to act on the plates.